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103

Takagi

TITLE: Liquid crystal display device manufacturing method involves planarizing polysilicon film surface by dry etching resist applied on polysilicon film

PATENT-ASSIGNEE: TOSHIBA KK[TOKE]

PRIORITY-DATA: 2000JP-0186562 (June 21, 2000)

PATENT-FAMILY:

PUB-NO	PUB-DATE	LANGUAGE	PAGES	MAIN-IPC
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APPLICATION-DATA:

PUB-NO	APPL-DESCRIPTOR	APPL-NO	APPL-DATE
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INT-CL (IPC): G02F001/1368, H05H001/46

ABSTRACTED-PUB-NO: JP2002006338A

BASIC-ABSTRACT:

NOVELTY - An amorphous silicon film formed on a glass substrate (1) is irradiated with energy beam, to form a polysilicon film (2). A resist (3) is applied on the polysilicon film. By dry etching of the resist, polysilicon film surface is planarized.

DETAILED DESCRIPTION - An INDEPENDENT CLAIM is also included for plasma processing device.

USE - For manufacturing LCD device with integrated TFTs.

ADVANTAGE - Planarizes polysilicon film by etching, to obtain high electron mobility.

DESCRIPTION OF DRAWING(S) - The figure shows a cross-sectional view of the plasma processing device.

Glass substrate 1

Polysilicon film 2

Resist 3

CHOSEN-DRAWING: Dwg.3/11

TITLE-TERMS: LIQUID CRYSTAL DISPLAY DEVICE MANUFACTURE METHOD PLANE FILM SURFACE DRY ETCH RESIST APPLY FILM

DERWENT-CLASS: L03 P81 U14 X14

CPI-CODES: L03-G05B; L04-E01E;

EPI-CODES: U14-K01A2B; X14-F;

SECONDARY-ACC-NO:

CPI Secondary Accession Numbers: C2002-098835

Non-CPI Secondary Accession Numbers: N2002-270717

PAT-NO: JP02002006338A

DOCUMENT-IDENTIFIER: JP 2002006338 A

TITLE: METHOD FOR MANUFACTURING LIQUID CRYSTAL DISPLAY DEVICE, AND PLASMA TREATMENT DEVICE

PUBN-DATE: January 9, 2002

INVENTOR-INFORMATION:

NAME	COUNTRY
TAKAGI, SHIGEYUKI	N/A

ASSIGNEE-INFORMATION:

NAME	COUNTRY
TOSHIBA CORP	N/A

APPL-NO: JP2000186562

APPL-DATE: June 21, 2000

INT-CL (IPC): G02F001/1368 , H05H001/46

ABSTRACT:

PROBLEM TO BE SOLVED: To provide a method for manufacturing a liquid crystal display device formed by flattening minute projection generated on a surface of a poly-Si film, and a plasma treatment device.

SOLUTION: A surface of poly-Si 2 is flattened by dry etching from the surface of a resist 3. Besides, the plasma treatment device keeps constant a space between a rear surface of microwave waveguides 17, 17a and 17b, and an upper surface of a microwave introduction window 14 by space controlling means 16, 16a, 16b and 16c.

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Ｈ０５Ｈ　1/46		Ｇ０２Ｆ　1/136	５００	

審査請求　未請求　請求項の数5　ＯＬ　（全 7 頁）

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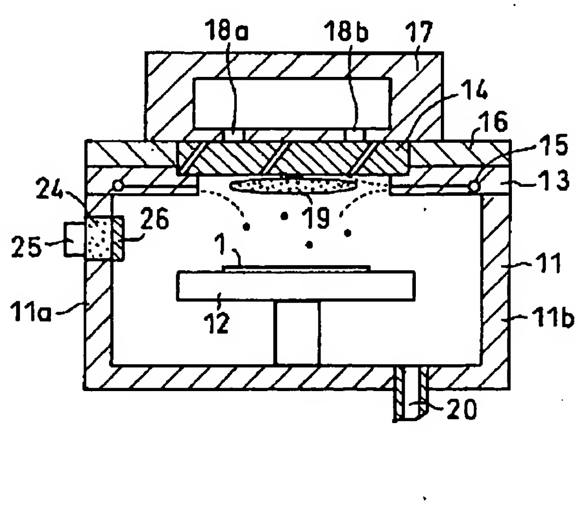
(54)【発明の名称】　液晶表示装置の製造方法およびプラズマ処理装置

(57)【要約】
【課題】　ｐｏｌｙ－Ｓｉ膜の表面に発生した微小な突起を平坦化して形成する液晶表示装置の製造方法とプラズマ処理装置を提供すること。
【解決手段】　レジスト３の表面からドライエッチングをおこなうことによりｐｏｌｙ－Ｓｉ２の表面を平坦化する。また、プラズマ処理装置は、マイクロ波導波管１７、１７ａ、１７ｂの下面とマイクロ波導入窓１４の上面との隙間は、隙間調整手段１６、１６ａ、１６ｂ、１６ｃによって一定に保つ。



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【特許請求の範囲】

【請求項1】　ガラス基板上に成膜されたアモルファスシリコン薄膜にエネルギービームを照射してポリシリコン薄膜を形成する工程と、

前記ポリシリコン薄膜の表面にレジストを塗布する工程と、

前記レジストの表面からドライエッチングをおこなうことにより前記ポリシリコンの表面を平坦化する工程とを有することを特徴とする液晶表示装置の製造方法。

【請求項2】　前記ポリシリコン薄膜の表面に前記レジストを塗布する工程に換えてSiO_2またはSi_3N_4による無機膜を形成する工程を有することを特徴とする請求項1記載の液晶表示装置の製造方法。

【請求項3】　前記ドライエッチングは、スロットアンテナ方式のプラズマ処理装置で行なうとともに、エッチングガスとして、フッ素を含んだガスと酸素を含んだガス、塩素を含んだガスと酸素を含んだガス、または、フッ素を含んだガス、塩素を含んだガスと酸素を含んだガスのいずれかの混合ガスを用いて行なうことを特徴とする請求項1記載の液晶表示装置の製造方法。

【請求項4】　マイクロ波導波管からのマイクロ波をマイクロ波導入窓を介してプロセスチャンバ内に導入し、前記プロセスチャンバ内の加工ステージ上の被加工体に照射して所定の処理を施すプラズマ処理装置において、前記マイクロ波導波管の下面とマイクロ波導入窓の上面との隙間は、隙間調整手段によって一定に保たれていることを特徴とするプラズマ処理装置。

【請求項5】　前記プロセスチャンバの側壁にはTiの酸化物を成膜した覗き窓が設けられていることを特徴とする請求項4記載のプラズマ処理装置。

【発明の詳細な説明】

【発明の属する技術分野】本発明は、薄膜トランジスタが組み込まれた液晶表示装置の製造方法とそれに用いるプラズマ処理装置に関する。

【従来の技術】液晶表示装置に組込まれる薄膜トランジスタは、従来よりソース、ドレイン領域が形成される活性層をアモルファスシリコン（以下、a−Siと称す）薄膜により形成していた。しかしながら、a−Si薄膜はトランジスタ特性に大きな影響を与えるキャリアの移動度が小さいという問題があった。このようなことから、液晶表示装置の薄膜トランジスタの特性（キャリアのモビリティ）を向上させるために活性層をpoly−Si薄膜で形成する技術が用いられている。特に、低温poly−Siは電子移動度が大きいため、従来のa−SiによるTFT−LCDでは、高精細化や画素制御用ドライバーICをガラス基板上に作り込むことは困難であったが、低温poly−SiによるTFT−LCDでは可能となるため、開発が行われている。図9はpoly−SiによるTFTの断面図である。ガラス基板61上に、順次poly−Si膜62、ゲート絶縁膜63、

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層間絶縁膜64およびpass−SiN膜65が形成されている。また、poly−Si膜62からpass−SiN膜65へは信号線66a、66bが設けられている。また、ゲート絶縁膜63上の層間絶縁膜64の内部のpoly−Si膜62と対向する位置にはゲート電極67が設けられている。なお、poly−Si膜62の形成方法は、ガラス基板61上にa−SiをプラズマCVD装置（不図示）を用いて成膜後、a−Si膜上にXeClエキシマレーザ（波長＝309nm、照射強度＝250〜350mJ／cm^2の紫外線）を照射し、多結晶化させてpoly−Si膜62を形成する。ところで、a−SiにXeClエキシマレーザを照射すると、図10にそれらにより形成されたガラス基板61上のpoly−Si膜62の表面のSEM写真を示すように、poly−Si膜の表面には数十nm程度の突起68a、68b…68nが存在している。これは、溶融後の再結晶の際に粒界に突起が発生するためである。突起発生のメカニズムを図11（a）〜（d）を参照してさらに説明する。まず、図11（a）に示すように、レーザ光の照射によりガラス基板61上のa−Si膜が溶融して溶融Si膜（poly−Si膜62）が形成される。これにより、図11（b）に示すように、poly−Si膜62の底部に結晶核71a、71b…71nが生成する。その後、図11（c）に示すように、ガラス基板61が冷えるに従い結晶72a、72b…72nが成長する。さらに、図11（d）に示すように、結晶72a、72b…72nに押されてpoly−Si膜62が粒界で突起68a、68b…68nとなる。この場合の突起68a、68b…68nの高さは、a−Siの膜厚が50nmであった場合、20〜50nmに達する。

【発明が解決しようとする課題】上述のように、低温poly−SiTFT−LCDでは、電子移動度の大きなpoly−Siを使用できるため、周辺駆動回路をガラス基板に内蔵でき、また、画素部のTFTが小さくなるため高開口率の高精細液晶デイスプレイが実現できる。しかしながら、poly−Si膜の表面には数十nm程度の突起が存在しているばあい、このpoly−Si薄膜をパターニングして活性層を形成し、その上にゲート絶縁膜、ゲート電極を形成した後、前記活性層にソース、ドレイン領域を形成して薄膜トランジスタを製造すると、poly−Siからなる活性層表面の突起に起因して、突起部での電界が高くなり、ゲート部の耐圧が低くなってゲート絶縁膜の耐圧不良を生じ、トランジスタ特性が著しく低下してしまう問題が生じる。本発明はこれらの事情にもとづいてなされたもので、poly−Si膜の表面に発生した微小な突起を平坦化して形成する液晶表示装置の製造方法とプラズマ処理装置を提供することを目的としている。

【課題を解決するための手段】本発明による手段によれば、ガラス基板上に成膜されたアモルファスシリコン薄

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膜にエネルギービームを照射してポリシリコン薄膜を形成する工程と、前記ポリシリコン薄膜の表面にレジストを塗布する工程と、前記レジストの表面からドライエッチングをおこなうことにより前記ポリシリコンの表面を平坦化する工程とを有することを特徴とする液晶表示装置の製造方法である。また本発明による手段によれば、前記ポリシリコン薄膜の表面に前記レジストを塗布する工程に換えてSiO_2またはSi_3N_4による無機膜を形成する工程を有することを特徴とする液晶表示装置の製造方法である。また本発明による手段によれば、前記無機膜は、SiO_2またはSi_3N_4により形成することを特徴とする液晶表示装置の製造方法である。また本発明による手段によれば、前記ドライエッチングは、スロットアンテナ方式のプラズマ処理装置で行なうとともに、エッチングガスとして、フッ素を含んだガスと酸素を含んだガス、塩素を含んだガスと酸素を含んだガス、または、フッ素を含んだガス、塩素を含んだガスと酸素を含んだガスのいずれかの混合ガスを用いて行なうことを特徴とする液晶表示装置の製造方法である。また本発明による手段によれば、前記エッチングガスにCF_4とO_2を用いた際に、CF_4とO_2の流量比を１／１０から１／２の範囲で使用することを特徴とする液晶表示装置の製造方法である。また本発明による手段によれば、マイクロ波導波管からのマイクロ波をマイクロ波導入窓を介してプロセスチャンバ内に導入し、前記プロセスチャンバ内の加工ステージ上の被加工体に照射して所定の処理を施すプラズマ処理装置において、前記マイクロ波導波管の下面とマイクロ波導入窓の上面との隙間は、隙間調整手段によって一定に保たれていることを特徴とするプラズマ処理装置である。また本発明による手段によれば、前記隙間調整手段は、スペーサの厚さを変化させることにより調整するものであることを特徴とするプラズマ処理装置である。また本発明による手段によれば、前記隙間調整手段は、調整板を調整ねじにより移動させることにより調整するものであることを特徴とするプラズマ処理装置である。また本発明による手段によれば、前記マイクロ波導入窓は、アルミナまたは窒化アルミで形成されていることを特徴とするプラズマ処理装置である。また本発明による手段によれば、前記プロセスチャンバの側壁にはＴｉの酸化物を成膜した覗き窓が設けられていることを特徴とするのプラズマ処理装置である。また本発明による手段によれば、前記Ｔｉの酸化物の成膜は、TiO_2を真空容器中で成膜するか、Ｔｉを含んだ液体を塗布後に加熱して乾燥させることにより成膜されたことを特徴とするプラズマ処理装置である。また本発明による手段によれば、前記覗き窓は、前記プロセスチャンバ内に水蒸気を導入し、この水蒸気に放電を発生させることにより行なうことを特徴とするプラズマ処理装置である。

【発明の実施の形態】以下、本発明に係わる液晶表示装置の薄膜トランジスタの製造方法の一例を説明する。

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（第１工程）まず、ガラス基板上の酸化ケイ素のような絶縁膜に、膜厚５００Åのａ－ＳｉをプラズマＣＶＤにより成膜する。なお、ガラス基板上には、絶縁膜の被覆前に予めゲート電極が形成されている。

（第２工程）次いで、ａ－Ｓｉ薄膜にエキシマレーザアニール装置により波長３０８ｎｍのレーザ光を３００ｍＪ／ｃｍ^{2}の強度で照射して多結晶化し、結晶性が良好なｐｏｌｙ－Ｓｉ薄膜に変換される。このｐｏｌｙ－Ｓｉ膜の表面には、数十ｎｍオーダの突起が発生している。なお、エネルギービームとしては、レーザビームの他に電子ビーム等を用いることもできる。

（第３工程）表面に突起が発生しているｐｏｌｙ－Ｓｉ膜上に、ｐｏｌｙ－Ｓｉと同じエッチングレートで加工できるレジストを塗布し、その後、エッチング装置を使用して、CF_4／O_2混合ガス系でエッチングを行いｐｏｌｙ－Ｓｉの突起を除去して平坦化する。この突起を除去する平坦化のメカニズムについて、図１（ａ）から（ｃ）を参照して説明する。まず、図１（ａ）に示すように、ガラス基板１の上に成膜された、多結晶化した突起４ａ、４ｂ、４ｃ…４ｎの存在するｐｏｌｙ－Ｓｉ膜２の膜上に膜厚１μｍのレジスト３を塗布する。次に、図１（ｂ）に示すように、例えば、スロットアンテナエッチング装置（不図示）を使用してエッチングを行う。その際のエッチングの条件は、図２に示すように、レジスト３とｐｏｌｙ－Ｓｉ膜２のエッチング速度を同一にする。例えば、マイクロ波出力：３ＫＷ×２台、CF_4／O_2ガス流量比：１５０／４００ｓｃｃｍ、エッチング圧力：２０Ｐａで行う。次に、図１（ｃ）に示すように、エッチングによりレジスト３が消滅したときに、同時にエッチングにより、ｐｏｌｙ－Ｓｉ膜２上の突起４ａ、４ｂ、４ｃ…４ｎも消滅する。なお、上述の場合は、突起を有するｐｏｌｙ－Ｓｉ膜２の上にレジストを塗布したが、レジストの代わりにSiO_2，Si_3N_4などの無機膜をＣＶＤ、スパッタ、塗布などの方法によって成膜して、その後ドライエッチング工程によりｐｏｌｙ－Ｓｉ膜を平坦化してもよい。また、エッチンガガスとしては、CF_4とO_2のように、フッ素を含んだガスと酸素を含んだガス、Cl_2とO_2のように、塩素を含んだガスと酸素を含んだガス、または、フッ素を含んだガス、塩素を含んだガスと酸素を含んだガスの各混合ガスを用いる。次に、これらの処理プロセスに用いた本発明のプラズマ処理装置について説明する。図３は本発明のプラズマ処理装置の構成を示す横断面構成図である。密閉容器に形成した反応室であるプロセスチャンバ１１は、内部にガラス基板１等の被加工体を載置する加工ステージ１２が設けられている。また、プロセスチャンバ１１の天井部は、側壁から中央部に向かってプラズマ源ベース１３が延在し、中央部は石英、セラミックなどの誘電体で形成されているマイクロ波導入窓１４と密

接している。また、プラズマ源ベース１３には反応ガスをプロセスチャンバ１１内に供給するためのガス供給口１５が設けられている。また、プラズマ源ベース１３の上部には、交換自在なスペーサ１６が密接して設けられており、スペーサ１６の側面はマイクロ波導入窓１４と密接し、また、スペーサ１６の上面とマイクロ波導入窓１４の上面は面一に形成されている。このスペーサ１６は、一枚の板で形成されていても、図４に示すように複数枚のスペーサ１６ａ、１６ｂ、１６ｃで形成されていてもよい。面一に形成されたマイクロ波導入窓１４とスペーサ１６の上面には、マイクロ波を公知のマイクロ波発生回路（不図示）から導くためのマイクロ波導波管１７が密接して設けられている。なお、マイクロ波導波管１７のマイクロ波導入窓１４に対応する位置には、マイクロ波を放出するためのマイクロ波放出口１８ａ、１８ｂが設けられている。なお、このマイクロ波放出口１８ａ、１８ｂは、その開口部をスロットアンテナとしての機能を果たす形状に形成している。次に、スペーサ１６の機能について説明すると、プラズマ処理装置のようなマイクロ波装置では、マイクロ波導波管１７に導かれたマイクロ波は、マイクロ波放出口１８ａ、１８ｂから放出され、マイクロ波導入窓１４を介して、プラズマ源ベース１３内に導入される。ここでマイクロ波はプロセスガスを励起し、プラズマ１９を発生させる。プラズマ１９で生成された活性原子、イオンなどの活性種は、プラセスチャンバ１１の底部に設けられた排気口２０へ向かうガス流に運ばれ加工ステージ１２上で被加工体をプロセス加工する。例えば、Ｓｉ、ＭｏＷ、ＳｉＮなどをエッチングする場合では、プロセスガスとしてCF_4、CHF_3などのフッ素化合物のガスを用いる。これらのガスは放電により分解され、フッ素あるいはフッ素ラジカルなどの活性種を発生する。マイクロ波導入窓１４として石英ガラスを用いた場合、活性種が反応して石英窓の削れが発生し、短時間での窓交換が必要であった。これを抑制するため、マイクロ波導入窓１４として、アルミナ、窒化アルミなどのセラミック材が用いられるようになり、窓の削れ量は１／１０～１／１００に減少した。しかしながら、より長時間使用した場合には、図５（ａ）で示すようにマイクロ波導入窓１４の表面に削れ２１が発生し、さらに、アルミナとフッ素が反応し表面状態が変質２２した。そこで、図５（ｂ）のようにマイクロ波導入窓１４を研磨する方式が考えられたが、研磨によりマイクロ波導入窓１４が薄くなるため、導波管３とマイクロ波導入窓１４とに隙間が発生し、これがプラズマの不安定性をもたらし、エッチングレート、均一性の変動を発生させる原因となっていた。この研磨する量αは表面の平行度を維持するため、０．１ｍｍ以上で、通常は１ｍｍ程度である。本発明では、これに応じで、スペーサ１６を１ｍｍ薄いスペーサ１６に交換する。これにより、マイクロ波導入窓１４の上面とマイクロ波導入管３の下面との隙間を一定に保持することができ、プラズマを安定に維持することができる。それにより、マイクロ波導入窓１４の研磨とスペーサ１６の交換は１回に限らず、マイクロ波導入窓１４が真空耐圧に耐えうる厚みまで、繰り返し使用することが可能となった。先に、図４で示したように、スペーサ１６をスペーサ１６の本体１６ａと調整用スペーサ１６ｂ、１６ｃとで構成した場合は、調整用スペーサ１６ｂ、１６ｃの板厚は、例えばマイクロ波導入窓１４の一回の研磨量である１ｍｍにする。この構成では、マイクロ波導入窓１４を研磨する毎に調整用スペーサ１６ｂ、１６ｃを１枚づつ外すことで、マイクロ波導入窓１４の上面とマイクロ波導波管１７の下面との隙間を一定に保持することができる。また、プロセスチャンバ１１の側壁１１ａ、１１ｂ…１１ｄの一つには、覗き窓２４が形成されている。エッチングやアッシングの終点検出には、覗き窓２４を通して反応容器内の発光分光を発光分光検出器２５で検出する方式を採用しているが、被加工体の処理枚数が約１０００枚を越えると、エッチングやアッシング後の反応生成物が覗き窓２４に付着することにより曇りが発生する。これにより、発光の検出強度が低下し、正確に終点が検出できない。そのため、本発明では光触媒として作用するTiO_2膜２６を内面に成膜した覗き窓２４を設けて、水蒸気放電を行うことにより、反応容器を大気解放して、洗浄することなしに窓の曇りを除去することが可能となった。例えば、TiO_2膜２６を１００μｍ内側に成膜した覗き窓２４の場合、以下の条件で水蒸気放電を発生させることにより、エッチングやアッシングの反応生成物であるフロロカーボン膜が除去されることを確認した。

マイクロ波出力：３ＫＷ×２台
H_2Oガス流量比：１０００ｓｃｃｍ
放電圧力：２０ｐａ
放電時間：２分

その結果を図６に示すように、放電前、曇りのため６５５ｎｍの波長の光の透過率が５０％まで低下していたが、放電処理後９０％まで回復した。従来、基板１０００枚処理ごとに反応容器を大気解放して、洗浄することにより覗き窓２４の曇りを除去していたが、本発明により、基板１０００枚処理ごとにTiO_2を成膜した覗き窓２４を持つスロットアンテナエッチング装置で水蒸気放電を２分間行うことにより曇りを除去することができ、装置稼働率を向上させることが可能となった。なお、覗き窓２４の内側に成膜する金属酸化物は、TiO_2に限らず他のＴｉの酸化物を用いることができる。また、TiO_2の成膜は、スパッタリングやＣＶＤやイオンプレーティング等を真空容器内で行なっても、テトラメトキシチタン（Ｔｉ（OCH_3））等のＴｉを含んだ液体を塗布後に加熱して乾燥させて成膜してもよい。次に、上述のプロセスチャンバ１１の第１の変形例を、図

７に示す構成の横断面図を用いて説明する。なお、図３と同一機能部分には同一符号を付して個々の説明を省略する。この変形例では、マイクロ波導入窓１４の厚み変化に対してマイクロ波導波管１７とマイクロ波導入窓１４との隙間を一定に保持する機構として、マイクロ波導波管１７の取付け位置調整機構を設けたものである。取付け位置調整機構はマイクロ波導波管１７に設けられた調整板３１ａ、３１ｂと、この調整板３１ａ、３１ｂを移動させる調整ねじ３２ａ、３２ｂで形成している。この取付け位置調整機構では、調整ねじ３２ａ、３２ｂを回転することで調整板３１ａ、３１ｂの位置を可変させる。それにより、洗浄、研磨にともないマイクロ波導入窓１４の板厚が減少するのに対応して、調整板３１ａ、３１ｂを上方向に移動させてマイクロ波導波管１７とマイクロ波導入窓１４との隙間を一定に保持する。また、第２の変形例を、図８に示す構成の横断面図を用いて説明する。なお、図３と同一機能部分には同一符号を付して個々の説明を省略する。この変形例では、複数のプラズマ発生部であるマイクロ波導波管１７ａ、１７ｂを並列に配置した装置に本発明を適用したものである。複数のマイクロ波導波管１７ａ、１７ｂの間には複数のマイクロ波導波管１７ａ、１７ｂを接続して支持するための梁部３５が設けられ、この梁部３５の上部には梁部スペーサ３６が設けられている。従って、上述の実施の形態で説明した調整と併せて、複数のマイクロ波導波管１７ａ、１７ｂの間に関する調整には、梁部スペーサ３６の交換、あるいは梁部スペーサ３６の枚数の変更により、マイクロ波導入窓１４ａ、１４ｂの板厚の変化に対応することができる。以上に述べたように、本発明の製造方法によれば、ｐｏｌｙ－Ｓｉ膜をエッチング処理を行うことにより、ｐｏｌｙ－Ｓｉ膜の表面形状が平坦になりゲート電極と信号線間で測定する層間絶縁膜の絶縁耐圧が３０Ｖより６０Ｖに向上した。また、本発明の各装置では、マイクロ波導入窓の板厚に応じてスペーサの板厚を調整することで、研磨したマイクロ波導入窓を複数回使用できるため、マイクロ波導入窓のランニングランコストを低減することができる。例えば、アルミナセラミックのマイクロ波導入窓は、サイズと材質にもよるがエッチングに適した高純度アルミナを用いた場合、例えば一枚７０万円で、一回毎に交換した場合は、７０万円のランニングコストとなっていた。これに対し、１回の洗浄・研磨にようすつ費用は１０万円程度であり、研磨して５回使用した場合、ランニングコストは１２０万円である。すべて交換した場合の３５０万円に比べて１／３程度のランニングコストであり、大幅なランニングコスト低減が可能となった。また、従来では、覗き窓の曇りを除去を、基板１０００枚処理する毎に反応容器を大気解放して、洗浄することにより行なっていたが、本発明のTiO_2を成膜した覗き窓によれば、基板１０００枚処理ごとに水蒸気放電を２分間行うことで、曇りを除去することができ、装置稼働率を大幅に向上させることが可能となった。なお、本発明のプラズマ処理装置は液晶表示装置の製造に限らず、半導体装置等の製造一般に広く用いることができる。

【発明の効果】本発明によれば、ｐｏｌｙ－Ｓｉ膜をエッチング処理を行うことにより、電子移動度の高いｐｏｌｙ－Ｓｉ膜表面を平坦化することができる。

【図面の簡単な説明】

【図１】（ａ）～（ｃ）は、突起を除去する平坦化のメカニズムの説明図。

【図２】ｐｏｌｙ－Ｓｉとレジストのエッチング速度を示すグラフ。

【図３】本発明のプラズマ処理装置の構成を示す横断面構成図。

【図４】本発明のスペーサの側面図。

【図５】（ａ）マイクロ波導入窓の表面の損傷の説明図、（ｂ）マイクロ波導入窓の研磨の説明図。

【図６】本発明の覗き窓を用いた水蒸気放電と発光分光検出器の出力を示すグラフ。

【図７】本発明のプラズマ処理装置の変形例の構成を示す横断面構成図。

【図８】本発明のプラズマ処理装置の変形例の構成を示す横断面構成図。

【図９】ｐｏｌｙ－ＳｉＴＦＴの構成断面図。

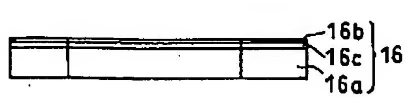
【図１０】ｐｏｌｙ－Ｓｉの表面形状の拡大図。

【図１１】（ａ）～（ｄ）は、ｐｏｌｙ－Ｓｉの突起発生のメカニズムの説明図。

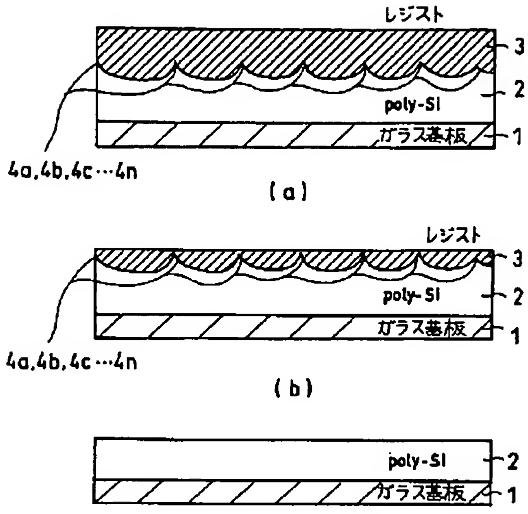
【符号の説明】

１…ガラス基板、２…ｐｏｌｙ－Ｓｉ、３…レジスト、４ａ、４ｂ、４ｃ～４ｎ…突起、５…、６…、７…、８…、９…、１０…、１１…プロセスチャンバ、１２…加工ステージ、１３…、１４…マイクロ波導入窓、１５…、１６、１６ａ、１６ｂ、１６ｃ…スペーサ、１７、１７ａ、１７ｂ…マイクロ波導波管、２４…覗き窓、２６…TiO_2膜、３２ａ、３２ｂ…調整ねじ、３６…梁部スペーサ

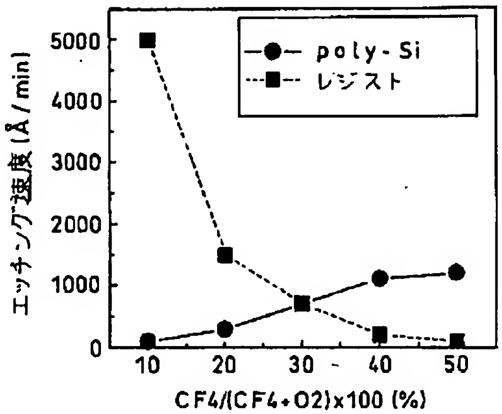
【図４】



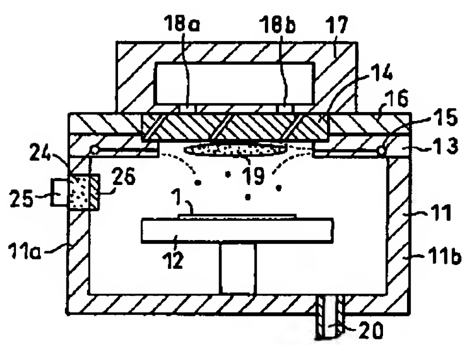
【図1】



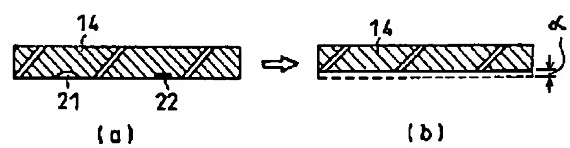
【図2】



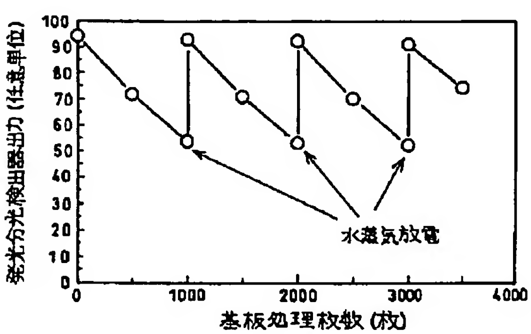
【図3】



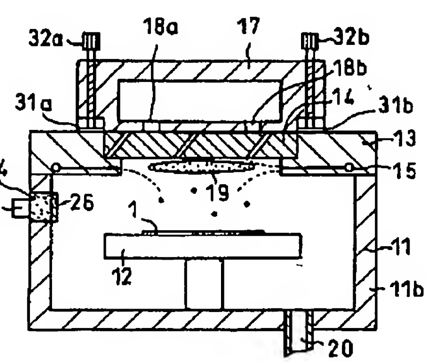
【図5】



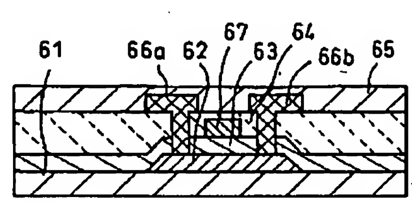
【図6】



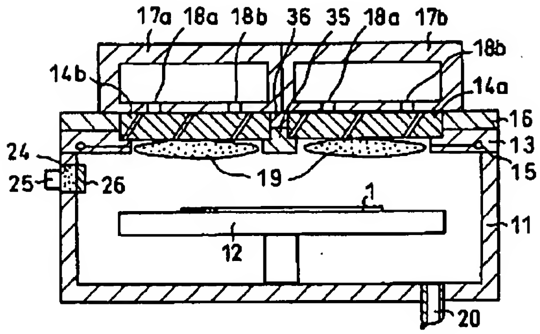
【図7】



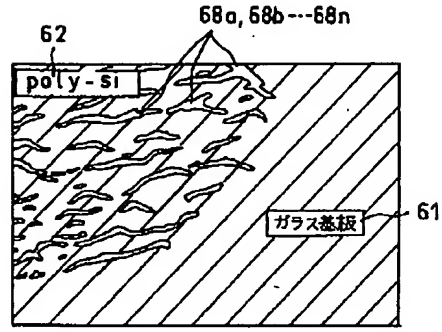
【図9】



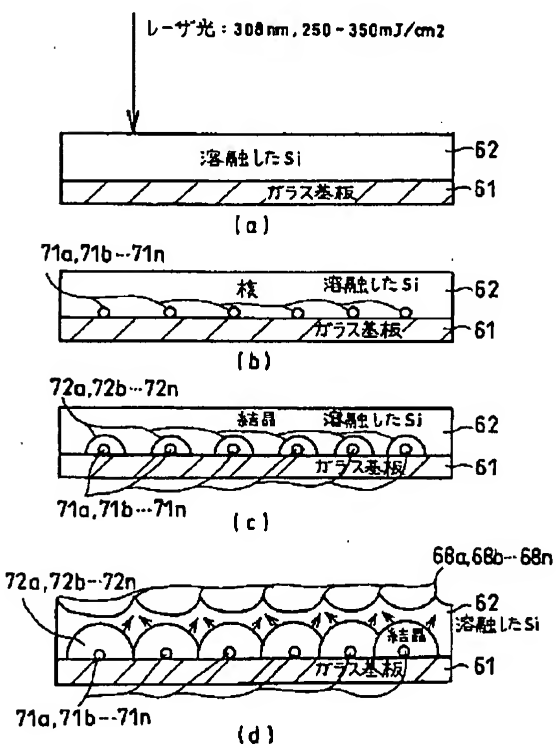
【図8】


17a
18a
18b
36
35
18a
17b
18b
14b
14a
16
13
24
25
26
19
15
1
11
12
20

【図10】


62
68a, 68b---68n
poly-Si
ガラス基板
61

【図11】


レーザ光：308nm，250－350mJ/cm2
溶融したSi
62
ガラス基板
61
(a)
71a,71b--71n
核
溶融したSi
62
ガラス基板
61
(b)
72a,72b--72n
結晶
溶融したSi
62
ガラス基板
61
71a,71b--71n
(c)
68a,68b--68n
72a,72b--72n
62
溶融したSi
結晶
ガラス基板
61
71a,71b--71n
(d)

JP2002-006,338

CLAIMS

[Claim(s)]
[Claim 1] The manufacture approach of the liquid crystal display characterized by having the process which irradiates a energy beam and forms a polish recon thin film in the amorphous silicon thin film formed on the glass substrate, the process which applies a resist to the front face of said polish recon thin film, and the process which carries out flattening of the front face of said polish recon by performing dry etching from the front face of said resist.
[Claim 2] The manufacture approach of the liquid crystal display according to claim 1 characterized by having the process which changes to the process which applies said resist to the front face of said polish recon thin film, and forms the inorganic film by SiO2 or Si3N4.
[Claim 3] Said dry etching is the manufacture approach of the liquid crystal display according to claim 1 characterized by carrying out as etching gas using one mixed gas of the gas containing a fluorine, the gas containing oxygen and the gas containing chlorine, the gas containing oxygen or the gas containing a fluorine, the gas containing chlorine, and the gas containing oxygen while the plasma treatment equipment of a slot antenna method performs.
[Claim 4] It is plasma treatment equipment characterized by keeping constant the clearance between the inferior surface of tongue of said microwave waveguide, and the top face of a microwave installation aperture by the clearance adjustment means in the plasma treatment equipment which introduces the microwave from microwave waveguide in a process chamber through a microwave installation aperture, irradiates the worked object on the processing stage in said process chamber, and performs predetermined processing.
[Claim 5] Plasma treatment equipment according to claim 4 characterized by preparing the inspection hole which formed the oxide of Ti in the side attachment wall of said process chamber.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[Field of the Invention] This invention relates to the plasma treatment equipment used for the manufacture approach of the liquid crystal display with which the thin film transistor was incorporated, and it.
[Description of the Prior Art] The thin film transistor included in a liquid crystal display formed the barrier layer in which the source and a drain field are formed conventionally with the amorphous silicon (a-Si is called hereafter) thin film. However, the a-Si thin film had the problem that the mobility of the carrier which has big effect on transistor characteristics was small. Since it is such, in order to raise the property (mobility of a carrier) of the thin film transistor of a liquid crystal display, the technique which forms a barrier layer with a poly-Si thin film is used. Since especially low-temperature poly-Si had large electron mobility, in TFT-LCD by conventional a-Si, it was difficult to make highly-minute-izing and the driver IC for pixel control on a glass substrate, but in TFT-LCD by low-temperature poly-Si, since it becomes possible, development is performed. Drawing 9 is the sectional view of TFT by poly-Si. On the glass substrate 61, the poly-Si film 62, gate dielectric film 63, an interlayer insulation film 64, and the pass-SiN film 65 are formed one by one. Moreover, signal lines 66a and 66b are formed in the pass-SiN film 65 from the poly-Si film 62. Moreover, the gate electrode 67 is formed in the poly-Si film 62 inside the interlayer insulation film 64 on gate dielectric film 63, and the location which counters. In addition, the formation approach of the poly-Si film 62 uses plasma-CVD equipment (un-illustrating) for a-Si on a glass substrate 61, after membrane formation, on the a-Si film, it irradiates XeCl excimer laser (wavelength =309nm, exposure reinforcement = ultraviolet rays of 250 - 350 mJ/cm2), makes it polycrystal-ize, and forms the poly-Si film 62. By the way, when XeCl excimer laser is irradiated at a-Si, in the front face of the poly-Si film, they are the projections 68a and 68b of about dozens of nm so that the SEM photograph of the front face of the poly-Si film 62 on the glass substrate 61 formed in drawing 10 of them may be shown. -- 68n exists. This is for a projection to occur in a grain boundary in the case of recrystallization after melting. The mechanism of projection generating is further explained with reference to drawing 11 (a) - (d). First, as shown in drawing 11 (a), the a-Si film on a glass substrate 61 fuses by the exposure of a laser beam, and the melting Si film (poly-Si film 62) is formed. Thereby, as shown in drawing 11 (b), they are crystalline nuclei 71a and 71b to the pars basilaris ossis occipitalis of the poly-Si film 62. -- 71n generates. Then, they are Crystals 72a and 72b as are shown in drawing 11 (c) and a glass substrate 61 gets cold. -- 72n grows. Furthermore, as shown in drawing 11 (d), they are Crystals 72a and 72b. -- It is pushed on 72n and the poly-Si film 62 is Projections 68a and 68b in a grain boundary. -- It is set to 68n. Projections 68a and 68b in this case -- Height of 68n amounts to 20-50nm, when the thickness of a-Si is 50nm.
[Problem(s) to be Solved by the Invention] As mentioned above, in low-temperature poly-SiTFT-LCD, since a circumference drive circuit can be built in a glass substrate since big poly-Si of electron mobility can be used, and TFT of the pixel section becomes small, the highly minute liquid crystal display of a quantity numerical aperture is realizable. However, when the projection of about dozens of nm exists in the front face of the poly-Si film, If the source and a drain field are formed in said barrier layer and a thin film transistor is manufactured after carrying out patterning of this poly-Si thin film, forming a barrier layer and forming gate dielectric film and a gate electrode on it It originates in the projection on the front face of a barrier layer which consists of poly-Si, the electric field in a height become high, pressure-proofing of the gate section becomes low, the poor proof pressure of gate dielectric film is produced, and while transistor characteristics fall remarkably, a title arises. This invention was made based on these situations, and aims at offering the manufacture approach of the liquid crystal display which carries out flattening of the minute projection generated on the front face of the poly-Si film, and forms it, and plasma treatment equipment.
[Means for Solving the Problem] It is the manufacture approach of the liquid crystal display characterized by having the process which irradiates a energy beam and forms a polish recon thin film in the amorphous silicon thin film

formed on the glass substrate, the process which applies a resist to the front face of said polish recon thin film, and the process which carries out flattening of the front face of said polish recon by performing dry etching from the front face of said resist according to the means by this invention. Moreover, according to the means by this invention, it is the manufacture approach of the liquid crystal display characterized by having the process which changes to the process which applies said resist to the front face of said polish recon thin film, and forms the inorganic film by SiO2 or Si3N4. Moreover, according to the means by this invention, said inorganic film is the manufacture approach of the liquid crystal display characterized by forming by SiO2 or Si3N4. Moreover, it is the manufacture approach of the liquid crystal display characterized by to carry out as etching gas using one mixed gas of the gas containing a fluorine, the gas containing oxygen and the gas containing chlorine, the gas containing oxygen or the gas containing a fluorine, the gas containing chlorine, and the gas containing oxygen while the plasma treatment equipment of a slot antenna method performs said dry etching according to the means by this invention. Moreover, according to the means by this invention, when CF4 and O2 are used for said etching gas, it is the manufacture approach of the liquid crystal display characterized by using the flow rate of CF4 and O2 in 1/10 to 1/2. Moreover, according to the means by this invention, in the plasma-treatment equipment which introduces the microwave from microwave waveguide in a process chamber through a microwave installation aperture, irradiates the worked object on the processing stage in said process chamber, and performs predetermined processing, the clearance between the inferior surface of tongue of said microwave waveguide and the top face of a microwave installation aperture is plasma-treatment equipment characterized by to be kept constant by the clearance adjustment means. Moreover, according to the means by this invention, said clearance adjustment means is plasma treatment equipment characterized by being what adjusted by changing the thickness of a spacer. Moreover, according to the means by this invention, said clearance adjustment means is plasma treatment equipment characterized by being what adjusted by moving a baffle plate with an adjusting screw. Moreover, according to the means by this invention, said microwave installation aperture is plasma treatment equipment characterized by being formed with an alumina or nitriding aluminum. Moreover, according to the means by this invention, it is characterizing [it]-by preparing inspection hole which formed oxide of Ti in side attachment wall of said process chamber plasma treatment equipment. Moreover, according to the means by this invention, membrane formation of the oxide of said Ti is plasma treatment equipment characterized by forming membranes by making it heat and dry after applying the liquid which formed TiO2 in the vacuum housing, or contained Ti. Moreover, according to the means by this invention, said inspection hole is plasma treatment equipment characterized by carrying out by introducing a steam in said process chamber and making this steam generate discharge.

[Embodiment of the Invention] Hereafter, an example of the manufacture approach of the thin film transistor of the liquid crystal display concerning this invention is explained.

(The 1st process) a-Si of 500A of thickness is first formed by plasma CVD to an insulator layer like the silicon oxide on a glass substrate. In addition, on the glass substrate, the gate electrode is beforehand formed before covering of an insulator layer.

(The 2nd process) Subsequently to an a-Si thin film, a laser beam with a wavelength of 308nm is irradiated by the reinforcement of 300 mJ/cm2 with a excimer laser annealer, it polycrystal-izes and crystallinity is changed into a good poly-Si thin film. The projection of dozens of nm order has occurred in the front face of this poly-Si film. In addition, as a energy beam, an electron beam etc. can also be used besides a laser beam.

(The 3rd process) The resist which can process it on a front face by the same etching rate as poly-Si on the poly-Si film which the projection has generated is applied, after that, an etching system is used, it etches by CF4 / O2 mixed-gas system, and flattening of the projection of poly-Si is removed and carried out. The mechanism of flattening which removes this projection is explained with reference to (c) from drawing 1 (a). First, polycrystal-ized projections 4a, 4b, and 4c which were formed on the glass substrate 1 as shown in drawing 1 (a) -- The resist 3 of 1 micrometer of thickness is applied on the 4n film of the existing poly-Si film 2. Next, as shown in drawing 1 (b), it etches using a slot antenna etching system (un-illustrating). The conditions of etching in that case make the same the etch rate of a resist 3 and the poly-Si film 2, as shown in drawing 2 . For example, CF[microwave output:3kWx2 set and] 4/O2 gas-stream quantitative-ratio:150/400sccm, an etching pressure: Carry out by 20Pa. Next, as shown in drawing 1 (c), when a resist 3 disappears by etching, they are the projections 4a, 4b, and 4c on the poly-Si film 2 by etching to coincidence. -- No less than 4n disappears. In addition, although the resist was applied on the poly-Si film 2 which has a projection, in an above-mentioned case, inorganic film, such as SiO2 and Si3N4, may be formed by approaches, such as CVD, a spatter, and spreading, instead of a resist, and it may carry out flattening of the poly-Si film according to a DORAI etching process after that. Moreover, etching uses each mixed gas of the gas which contained the fluorine like CF4 and O2 as gas, the gas which contained chlorine like the gas containing oxygen, and Cl2 and O2, the gas containing oxygen or the gas containing a fluorine, the gas containing chlorine, and the gas containing oxygen. Next, the plasma treatment

equipment of this invention used for these treatment processes is explained. Drawing 3 is the cross-section block diagram showing the configuration of the plasma treatment equipment of this invention. The processing stage 12 where the process chamber 11 which is the reaction chamber formed in the well-closed container lays the worked object of glass substrate 1 grade in the interior is formed. Moreover, the source base 13 of the plasma extends toward a side attachment wall to a center section, and, as for the head-lining section of the process chamber 11, the center section is close with the microwave installation aperture 14 currently formed with dielectrics, such as a quartz and a ceramic. Moreover, the gas supply opening 15 for supplying reactant gas in the process chamber 11 is formed in the source base 13 of the plasma. Moreover, it is [the freely exchangeable spacer 16] close, it is formed in the upper part of the source base 13 of the plasma, and the side face of a spacer 16 is close with the microwave installation aperture 14, and the top face of a spacer 16 and the top face of the microwave installation aperture 14 are formed flat-tapped. Even if this spacer 16 is formed with one plate, as shown in drawing 4 , it may be formed with the spacers 16a, 16b, and 16c of two or more sheets. It is [the microwave waveguide 17 for drawing microwave from a well-known microwave generating circuit (un-illustrating)] close, and it is formed in the microwave installation aperture 14 formed flat-tapped and the top face of a spacer 16. In addition, the microwave emission openings 18a and 18b for emitting microwave are formed in the location corresponding to the microwave installation aperture 14 of a microwave waveguide 17. In addition, these microwave emission openings 18a and 18b form that opening in the configuration which achieves the function as a slot antenna. Next, if the function of a spacer 16 is explained, in a microwave device like plasma treatment equipment, the microwave led to the microwave waveguide 17 will be emitted from the microwave emission openings 18a and 18b, and will be introduced in the source base 13 of the plasma through the microwave installation aperture 14. Microwave excites process gas and generates the plasma 19 here. Active species generated with the plasma 19, such as an activity atom and ion, are carried by the gas stream which goes to the exhaust port 20 established in the pars basilaris ossis occipitalis of the PURASESU chamber 11, and carry out process processing of the worked object on the processing stage 12. For example, in the case where Si, MoW, SiN, etc. are etched, the gas of fluorine compounds, such as CF4 and CHF3, is used as process gas. It is decomposed by discharge and these gas generates active species, such as a fluorine or a fluorine radical. When quartz glass was used as a microwave installation aperture 14, active species reacted, **** of a quartz aperture occurred, and aperture exchange in a short time was required. In order to control this, as a microwave installation aperture 14, ceramic material, such as an alumina and nitriding aluminum, came to be used, the aperture could be deleted, and the amount decreased to 1 / 10 - 1/100. However, when it was used more for a long time, as drawing 5 (a) showed, it could delete on the front face of the microwave installation aperture 14, and 21 occurred, further, the alumina and the fluorine reacted and the surface state took deterioration 22. Then, although the method which grinds the microwave installation aperture 14 like drawing 5 (b) was able to be considered, since the microwave installation aperture 14 became thin by polish, the clearance occurred in the waveguide 3 and the microwave installation aperture 14, this brought about the instability of the plasma, and it had become an etching rate and the cause of generating homogeneous fluctuation. For a ****** reason, this amount alpha to grind is 0.1mm or more about surface parallelism, and is usually about 1mm. in this invention, it comes out according to this and a spacer 16 is exchanged for the spacer 16 thin 1mm. Thereby, the clearance between the top face of the microwave installation aperture 14 and the inferior surface of tongue of the microwave installation tubing 3 can be held uniformly, and the plasma can be maintained to stability. Thereby, polish of the microwave installation aperture 14 and exchange of a spacer 16 became able [not only 1 time but the microwave installation aperture 14] to use it to the thickness which can be equal to vacuum pressure-proofing repeatedly. Previously, it is drawing 4 . As shown, when it comes out and SU **-SA 16 is constituted from body 16a of a spacer 16, and spacers 16b and 16c for adjustment, board thickness of the spacers 16b and 16c for adjustment is set to 1mm which is 1 time of the amount of polishes of the microwave installation aperture 14. With this configuration, the clearance between the top face of the microwave installation aperture 14 and the inferior surface of tongue of a microwave waveguide 17 can be uniformly held by removing one spacer 16b and 16c for adjustment at a time, whenever it grinds the microwave installation aperture 14. Moreover, side attachment walls 11a and 11b of the process chamber 11 -- The inspection hole 24 is formed in one [11d]. Although the method which detects the emission spectrometry in a reaction container with the emission spectrometry detector 25 through an inspection hole 24 is adopted as etching or terminal point detection of ashing, if the processing number of sheets of a worked object exceeds about 1000 sheets, when the resultant after etching or ashing adheres to an inspection hole 24, cloudiness will occur. Thereby, the detection reinforcement of luminescence falls and a terminal point cannot be detected correctly. Therefore, it became possible to remove the cloudiness of an aperture by forming the inspection hole 24 which formed inside TiO2 film 26 which acts as a photocatalyst in this invention, and performing steam discharge, without having carried out atmospheric-air release and washing a reaction container. For example, in the case of the inspection hole 24 which formed TiO2 film 26 to 100-micrometer inside, it checked that the fluorocarbon

film which is the resultant of etching or ashing was removed by generating steam discharge on condition that the following.
microwave output: -- 3kWx two-set H_2O quantity-of-gas-flow ratio: -- 1000sccm discharge pressure: -- 20pa charging-time-value: -- the result was recovered to 90% after electrodischarge treatment for 2 minutes, although the permeability of light with a wavelength of 655nm was falling to 50% before discharge for cloudiness as shown in drawing 6 . Although the cloudiness of an inspection hole 24 was removed by carrying out atmospheric-air release and washing a reaction container for every 1000 substrates processing conventionally, by performing steam discharge for 2 minutes by the slot antenna etching system which has the inspection hole 24 which formed TiO_2 for every 1000 substrates processing by this invention, cloudiness could be removed and it became possible to raise an equipment operating ratio. In addition, the oxide of not only TiO_2 but other Ti can be used for the metallic oxide which forms membranes inside an inspection hole 24. Moreover, even if membrane formation of TiO_2 performs sputtering, CVD, ion plating, etc. within a vacuum housing, it may be made to heat and dry, after applying the liquid containing Ti, such as tetramethoxy titanium (Ti (OCH_3)), and membranes may be formed. Next, it explains using the cross-sectional view of a configuration of that the 1st modification of the above-mentioned process chamber 11 is shown in drawing 7. In addition, the same sign is given to the same functional division as drawing 3 , and each explanation is omitted. In this modification, the fitting location adjustment device of a microwave waveguide 17 is established as a device in which the clearance between a microwave waveguide 17 and the microwave installation aperture 14 is uniformly held to thickness change of the microwave installation aperture 14. The fitting location adjustment device is formed with the adjusting screws 32a and 32b to which the baffle plates 31a and 31b formed in the microwave waveguide 17 and these baffle plates 31a and 31b are moved. By this fitting location adjustment device, it carries out adjustable [of the location of baffle plates 31a and 31b] by rotating adjusting screws 32a and 32b. Thereby, corresponding to the board thickness of the microwave installation aperture 14 decreasing with washing and polish, baffle plates 31a and 31b are moved upward, and the clearance between a microwave waveguide 17 and the microwave installation aperture 14 is held uniformly. Moreover, it explains using the cross-sectional view of a configuration of that the 2nd modification is shown in drawing 8 . In addition, the same sign is given to the same functional division as drawing 3 , and each explanation is omitted. In this modification, this invention is applied to the equipment which has arranged to juxtaposition the microwave waveguides 17a and 17b which are two or more plasma generating sections. Among two or more microwave waveguides 17a and 17b, the beam section 35 for connecting and supporting two or more microwave waveguides 17a and 17b is formed, and the beam section spacer 36 is formed in the upper part of this beam section 35. Therefore, it can combine with the adjustment explained with the gestalt of above-mentioned operation, and can respond to adjustment about between two or more microwave waveguides 17a and 17b at change of the board thickness of the microwave installation apertures 14a and 14b by exchange of the beam section spacer 36 or modification of the number of sheets of the beam section spacer 36. As stated above, according to the manufacture approach of this invention, the withstand voltage of the interlayer insulation film which the shape of surface type of the poly-Si film becomes flat, and measures the poly-Si film between a gate electrode and a signal line by performing etching processing improved from 30V to 60V. Moreover, with each equipment of this invention, by adjusting the board thickness of a spacer according to the board thickness of a microwave installation aperture, since the multiple-times use of the ground microwave installation aperture can be carried out, the running run cost of a microwave installation aperture can be reduced. For example, although the microwave installation aperture of an alumina ceramic was based also on size and the quality of the material, when the high purity alumina suitable for etching was used, for example, when it was 700,000 yen per sheet and exchanged for every time, it had become a 700,000 yen running cost. On the other hand, when situation ****** is about 100,000 yen, and it grinds at one washing and polish and is used 5 times, the price of a running cost is 1,200,000 yen. Compared with 3,500,000 yen at the time of exchanging all, it is about 1/3 running cost, and sharp running cost reduction was attained. Moreover, although removal was performed by carrying out atmospheric-air release and washing a reaction container in the former whenever it processed the cloudiness of an inspection hole 1000 substrates, according to the inspection hole which formed TiO_2 of this invention, cloudiness could be removed by performing steam discharge for 2 minutes for every 1000 substrates processing, and it became possible to raise an equipment operating ratio sharply. In addition, the plasma treatment equipment of this invention can be widely used for general manufacture, such as not only manufacture of a liquid crystal display but a semiconductor device.
[Effect of the Invention] According to this invention, flattening of the high poly-Si film front face of electron mobility can be carried out by performing etching processing for the poly-Si film.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention] This invention relates to the plasma treatment equipment used for the manufacture approach of the liquid crystal display with which the thin film transistor was incorporated, and it.

[Translation done.]

PRIOR ART

[Description of the Prior Art] The thin film transistor included in a liquid crystal display formed the barrier layer in which the source and a drain field are formed conventionally with the amorphous silicon (a-Si is called hereafter) thin film. However, the a-Si thin film had the problem that the mobility of the carrier which has big effect on transistor characteristics was small. Since it is such, in order to raise the property (mobility of a carrier) of the thin film transistor of a liquid crystal display, the technique which forms a barrier layer with a poly-Si thin film is used. Since especially low-temperature poly-Si had large electron mobility, in TFT-LCD by conventional a-Si, it was difficult to make highly-minute-izing and the driver IC for pixel control on a glass substrate, but in TFT-LCD by low-temperature poly-Si, since it becomes possible, development is performed. Drawing 9 is the sectional view of TFT by poly-Si. On the glass substrate 61, the poly-Si film 62, gate dielectric film 63, an interlayer insulation film 64, and the pass-SiN film 65 are formed one by one. Moreover, signal lines 66a and 66b are formed in the pass-SiN film 65 from the poly-Si film 62. Moreover, the gate electrode 67 is formed in the poly-Si film 62 inside the interlayer insulation film 64 on gate dielectric film 63, and the location which counters. In addition, the formation approach of the poly-Si film 62 uses plasma-CVD equipment (un-illustrating) for a-Si on a glass substrate 61, after membrane formation, on the a-Si film, it irradiates XeCl excimer laser (wavelength =309nm, exposure reinforcement = ultraviolet rays of 250 - 350 mJ/cm2), makes it polycrystal-ize, and forms the poly-Si film 62. By the way, when XeCl excimer laser is irradiated at a-Si, in the front face of the poly-Si film, they are the projections 68a and 68b of about dozens of nm so that the SEM photograph of the front face of the poly-Si film 62 on the glass substrate 61 formed in drawing 10 of them may be shown. -- 68n exists. This is for a projection to occur in a grain boundary in the case of recrystallization after melting. The mechanism of projection generating is further explained with reference to drawing 11 (a) - (d). First, as shown in drawing 11 (a), the a-Si film on a glass substrate 61 fuses by the exposure of a laser beam, and the melting Si film (poly-Si film 62) is formed. Thereby, as shown in drawing 11 (b), they are crystalline nuclei 71a and 71b to the pars basilaris ossis occipitalis of the poly-Si film 62. -- 71n generates. Then, they are Crystals 72a and 72b as are shown in drawing 11 (c) and a glass substrate 61 gets cold. -- 72n grows. Furthermore, as shown in drawing 11 (d), they are Crystals 72a and 72b. -- It is pushed on 72n and the poly-Si film 62 is Projections 68a and 68b in a grain boundary. -- It is set to 68n. Projections 68a and 68b in this case -- Height of 68n amounts to 20-50nm, when the thickness of a-Si is 50nm.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] According to this invention, flattening of the high poly-Si film front face of electron mobility can be carried out by performing etching processing for the poly-Si film.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] As mentioned above, in low-temperature poly-SiTFT-LCD, since a circumference drive circuit can be built in a glass substrate since big poly-Si of electron mobility can be used, and TFT of the pixel section becomes small, the highly minute liquid crystal display of a quantity numerical aperture is realizable. However, when the projection of about dozens of nm exists in the front face of the poly-Si film, If the source and a drain field are formed in said barrier layer and a thin film transistor is manufactured after carrying out patterning of this poly-Si thin film, forming a barrier layer and forming gate dielectric film and a gate electrode on it It originates in the projection on the front face of a barrier layer which consists of poly-Si, the electric field in a height become high, pressure-proofing of the gate section becomes low, the poor proof pressure of gate dielectric film is produced, and while transistor characteristics fall remarkably, a title arises. This invention was made based on these situations, and aims at offering the manufacture approach of the liquid crystal display which carries out flattening of the minute projection generated on the front face of the poly-Si film, and forms it, and plasma treatment equipment.

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MEANS

[Means for Solving the Problem] It is the manufacture approach of the liquid crystal display characterized by having the process which irradiates a energy beam and forms a polish recon thin film in the amorphous silicon thin film formed on the glass substrate, the process which applies a resist to the front face of said polish recon thin film, and the process which carries out flattening of the front face of said polish recon by performing dry etching from the front face of said resist according to the means by this invention. Moreover, according to the means by this invention, it is the manufacture approach of the liquid crystal display characterized by having the process which changes to the process which applies said resist to the front face of said polish recon thin film, and forms the inorganic film by SiO_2 or Si_3N_4. Moreover, according to the means by this invention, said inorganic film is the manufacture approach of the liquid crystal display characterized by forming by SiO_2 or Si_3N_4. Moreover, it is the manufacture approach of the liquid crystal display characterized by to carry out as etching gas using one mixed gas of the gas containing a fluorine, the gas containing oxygen and the gas containing chlorine, the gas containing oxygen or the gas containing a fluorine, the gas containing chlorine, and the gas containing oxygen while the plasma treatment equipment of a slot antenna method performs said dry etching according to the means by this invention. Moreover, according to the means by this invention, when CF_4 and O_2 are used for said etching gas, it is the manufacture approach of the liquid crystal display characterized by using the flow rate of CF_4 and O_2 in 1/10 to 1/2. Moreover, according to the means by this invention, in the plasma-treatment equipment which introduces the microwave from microwave waveguide in a process chamber through a microwave installation aperture, irradiates the worked object on the processing stage in said process chamber, and performs predetermined processing, the clearance between the inferior surface of tongue of said microwave waveguide and the top face of a microwave installation aperture is plasma-treatment equipment characterized by to be kept constant by the clearance adjustment means. Moreover, according to the means by this invention, said clearance adjustment means is plasma treatment equipment characterized by being what adjusted by changing the thickness of a spacer. Moreover, according to the means by this invention, said clearance adjustment means is plasma treatment equipment characterized by being what adjusted by moving a baffle plate with an adjusting screw. Moreover, according to the means by this invention, said microwave installation aperture is plasma treatment equipment characterized by being formed with an alumina or nitriding aluminum. Moreover, according to the means by this invention, it is characterizing [it]-by preparing inspection hole which formed oxide of Ti in side attachment wall of said process chamber plasma treatment equipment. Moreover, according to the means by this invention, membrane formation of the oxide of said Ti is plasma treatment equipment characterized by forming membranes by making it heat and dry after applying the liquid which formed TiO_2 in the vacuum housing, or contained Ti. Moreover, according to the means by this invention, said inspection hole is plasma treatment equipment characterized by carrying out by introducing a steam in said process chamber and making this steam generate discharge.
[Embodiment of the Invention] Hereafter, an example of the manufacture approach of the thin film transistor of the liquid crystal display concerning this invention is explained.
(The 1st process) a-Si of 500A of thickness is first formed by plasma CVD to an insulator layer like the silicon oxide on a glass substrate. In addition, on the glass substrate, the gate electrode is beforehand formed before covering of an insulator layer.
(The 2nd process) Subsequently to an a-Si thin film, a laser beam with a wavelength of 308nm is irradiated by the reinforcement of 300 mJ/cm2 with a excimer laser annealer, it polycrystal-izes and crystallinity is changed into a good poly-Si thin film. The projection of dozens of nm order has occurred in the front face of this poly-Si film. In addition, as a energy beam, an electron beam etc. can also be used besides a laser beam.
(The 3rd process) The resist which can process it on a front face by the same etching rate as poly-Si on the poly-Si film which the projection has generated is applied, after that, an etching system is used, it etches by CF_4 / O_2 mixed-gas

system, and flattening of the projection of poly-Si is removed and carried out. The mechanism of flattening which removes this projection is explained with reference to (c) from drawing 1 (a). First, polycrystal-ized projections 4a, 4b, and 4c which were formed on the glass substrate 1 as shown in drawing 1 (a) -- The resist 3 of 1 micrometer of thickness is applied on the 4n film of the existing poly-Si film 2. Next, as shown in drawing 1 (b), it etches using a slot antenna etching system (un-illustrating). The conditions of etching in that case make the same the etch rate of a resist 3 and the poly-Si film 2, as shown in drawing 2 . For example, CF[microwave output:3kWx2 set and] 4/O2 gas-stream quantitative-ratio:150/400sccm, an etching pressure: Carry out by 20Pa. Next, as shown in drawing 1 (c), when a resist 3 disappears by etching, they are the projections 4a, 4b, and 4c on the poly-Si film 2 by etching to coincidence. -- No less than 4n disappears. In addition, although the resist was applied on the poly-Si film 2 which has a projection, in an above-mentioned case, inorganic film, such as SiO2 and Si3N4, may be formed by approaches, such as CVD, a spatter, and spreading, instead of a resist, and it may carry out flattening of the poly-Si film according to a DORAI etching process after that. Moreover, etching uses each mixed gas of the gas which contained the fluorine like CF4 and O2 as gas, the gas which contained chlorine like the gas containing oxygen, and Cl2 and O2, the gas containing oxygen or the gas containing a fluorine, the gas containing chlorine, and the gas containing oxygen. Next, the plasma treatment equipment of this invention used for these treatment processes is explained. Drawing 3 is the cross-section block diagram showing the configuration of the plasma treatment equipment of this invention. The processing stage 12 where the process chamber 11 which is the reaction chamber formed in the well-closed container lays the worked object of glass substrate 1 grade in the interior is formed. Moreover, the source base 13 of the plasma extends toward a side attachment wall to a center section, and, as for the head-lining section of the process chamber 11, the center section is close with the microwave installation aperture 14 currently formed with dielectrics, such as a quartz and a ceramic. Moreover, the gas supply opening 15 for supplying reactant gas in the process chamber 11 is formed in the source base 13 of the plasma. Moreover, it is [the freely exchangeable spacer 16] close, it is formed in the upper part of the source base 13 of the plasma, and the side face of a spacer 16 is close with the microwave installation aperture 14, and the top face of a spacer 16 and the top face of the microwave installation aperture 14 are formed flat-tapped. Even if this spacer 16 is formed with one plate, as shown in drawing 4 , it may be formed with the spacers 16a, 16b, and 16c of two or more sheets. It is [the microwave waveguide 17 for drawing microwave from a well-known microwave generating circuit (un-illustrating)] close, and it is formed in the microwave installation aperture 14 formed flat-tapped and the top face of a spacer 16. In addition, the microwave emission openings 18a and 18b for emitting microwave are formed in the location corresponding to the microwave installation aperture 14 of a microwave waveguide 17. In addition, these microwave emission openings 18a and 18b form that opening in the configuration which achieves the function as a slot antenna. Next, if the function of a spacer 16 is explained, in a microwave device like plasma treatment equipment, the microwave led to the microwave waveguide 17 will be emitted from the microwave emission openings 18a and 18b, and will be introduced in the source base 13 of the plasma through the microwave installation aperture 14. Microwave excites process gas and generates the plasma 19 here. Active species generated with the plasma 19, such as an activity atom and ion, are carried by the gas stream which goes to the exhaust port 20 established in the pars basilaris ossis occipitalis of the PURASESU chamber 11, and carry out process processing of the worked object on the processing stage 12. For example, in the case where Si, MoW, SiN, etc. are etched, the gas of fluorine compounds, such as CF4 and CHF3, is used as process gas. It is decomposed by discharge and these gas generates active species, such as a fluorine or a fluorine radical. When quartz glass was used as a microwave installation aperture 14, active species reacted, **** of a quartz aperture occurred, and aperture exchange in a short time was required. In order to control this, as a microwave installation aperture 14, ceramic material, such as an alumina and nitriding aluminum, came to be used, the aperture could be deleted, and the amount decreased to 1 / 10 - 1/100. However, when it was used more for a long time, as drawing 5 (a) showed, it could delete on the front face of the microwave installation aperture 14, and 21 occurred, further, the alumina and the fluorine reacted and the surface state took deterioration 22. Then, although the method which grinds the microwave installation aperture 14 like drawing 5 (b) was able to be considered, since the microwave installation aperture 14 became thin by polish, the clearance occurred in the waveguide 3 and the microwave installation aperture 14, this brought about the instability of the plasma, and it had become an etching rate and the cause of generating homogeneous fluctuation. For a ****** reason, this amount alpha to grind is 0.1mm or more about surface parallelism, and is usually about 1mm. in this invention, it comes out according to this and a spacer 16 is exchanged for the spacer 16 thin 1mm. Thereby, the clearance between the top face of the microwave installation aperture 14 and the inferior surface of tongue of the microwave installation tubing 3 can be held uniformly, and the plasma can be maintained to stability. Thereby, polish of the microwave installation aperture 14 and exchange of a spacer 16 became able [not only 1 time but the microwave installation aperture 14] to use it to the thickness which can be equal to vacuum pressure-proofing repeatedly. As drawing 4 showed, when SU **-SA 16 is previously constituted

from body 16a of a spacer 16, and spacers 16b and 16c for adjustment, they are the spacers 16b and 16c for adjustment. Board thickness is set to 1mm which is 1 time of the amount of polishes of the microwave installation aperture 14. With this configuration, the clearance between the top face of the microwave installation aperture 14 and the inferior surface of tongue of a microwave waveguide 17 can be uniformly held by removing one spacer 16b and 16c for adjustment at a time, whenever it grinds the microwave installation aperture 14. Moreover, side attachment walls 11a and 11b of the process chamber 11 -- The inspection hole 24 is formed in one [11d]. Although the method which detects the emission spectrometry in a reaction container with the emission spectrometry detector 25 through an inspection hole 24 is adopted as etching or terminal point detection of ashing, if the processing number of sheets of a worked object exceeds about 1000 sheets, when the resultant after etching or ashing adheres to an inspection hole 24, cloudiness will occur. Thereby, the detection reinforcement of luminescence falls and a terminal point cannot be detected correctly. Therefore, it became possible to remove the cloudiness of an aperture by forming the inspection hole 24 which formed inside TiO2 film 26 which acts as a photocatalyst in this invention, and performing steam discharge, without having carried out atmospheric-air release and washing a reaction container. For example, in the case of the inspection hole 24 which formed TiO2 film 26 to 100-micrometer inside, it checked that the fluorocarbon film which is the resultant of etching or ashing was removed by generating steam discharge on condition that the following.

microwave output: -- 3kWx two-set H2O quantity-of-gas-flow ratio: -- 1000sccm discharge pressure: -- 20pa charging-time-value: -- the result was recovered to 90% after electrodischarge treatment for 2 minutes, although the permeability of light with a wavelength of 655nm was falling to 50% before discharge for cloudiness as shown in drawing 6 . Although the cloudiness of an inspection hole 24 was removed by carrying out atmospheric-air release and washing a reaction container for every 1000 substrates processing conventionally, by performing steam discharge for 2 minutes by the slot antenna etching system which has the inspection hole 24 which formed TiO2 for every 1000 substrates processing by this invention, cloudiness could be removed and it became possible to raise an equipment operating ratio. In addition, the oxide of not only TiO2 but other Ti can be used for the metallic oxide which forms membranes inside an inspection hole 24. Moreover, even if membrane formation of TiO2 performs sputtering, CVD, ion plating, etc. within a vacuum housing, it may be made to heat and dry, after applying the liquid containing Ti, such as tetramethoxy titanium (Ti (OCH3)), and membranes may be formed. Next, it explains using the cross-sectional view of a configuration of that the 1st modification of the above-mentioned process chamber 11 is shown in drawing 7. In addition, the same sign is given to the same functional division as drawing 3 , and each explanation is omitted. In this modification, the fitting location adjustment device of a microwave waveguide 17 is established as a device in which the clearance between a microwave waveguide 17 and the microwave installation aperture 14 is uniformly held to thickness change of the microwave installation aperture 14. The fitting location adjustment device is formed with the adjusting screws 32a and 32b to which the baffle plates 31a and 31b formed in the microwave waveguide 17 and these baffle plates 31a and 31b are moved. By this fitting location adjustment device, it carries out adjustable [of the location of baffle plates 31a and 31b] by rotating adjusting screws 32a and 32b. Thereby, corresponding to the board thickness of the microwave installation aperture 14 decreasing with washing and polish, baffle plates 31a and 31b are moved upward, and the clearance between a microwave waveguide 17 and the microwave installation aperture 14 is held uniformly. Moreover, it explains using the cross-sectional view of a configuration of that the 2nd modification is shown in drawing 8 . In addition, the same sign is given to the same functional division as drawing 3 , and each explanation is omitted. In this modification, this invention is applied to the equipment which has arranged to juxtaposition the microwave waveguides 17a and 17b which are two or more plasma generating sections. Among two or more microwave waveguides 17a and 17b, the beam section 35 for connecting and supporting two or more microwave waveguides 17a and 17b is formed, and the beam section spacer 36 is formed in the upper part of this beam section 35. Therefore, it can combine with the adjustment explained with the gestalt of above-mentioned operation, and can respond to adjustment about between two or more microwave waveguides 17a and 17b at change of the board thickness of the microwave installation apertures 14a and 14b by exchange of the beam section spacer 36 or modification of the number of sheets of the beam section spacer 36. As stated above, according to the manufacture approach of this invention, the withstand voltage of the interlayer insulation film which the shape of surface type of the poly-Si film becomes flat, and measures the poly-Si film between a gate electrode and a signal line by performing etching processing improved from 30V to 60V. Moreover, with each equipment of this invention, by adjusting the board thickness of a spacer according to the board thickness of a microwave installation aperture, since the multiple-times use of the ground microwave installation aperture can be carried out, the running run cost of a microwave installation aperture can be reduced. For example, although the microwave installation aperture of an alumina ceramic was based also on size and the quality of the material, when the high purity alumina suitable for etching was used, for example,

when it was 700,000 yen per sheet and exchanged for every time, it had become a 700,000 yen running cost. On the other hand, when situation ****** is about 100,000 yen, and it grinds at one washing and polish and is used 5 times, the price of a running cost is 1,200,000 yen. Compared with 3,500,000 yen at the time of exchanging all, it is about 1/3 running cost, and sharp running cost reduction was attained. Moreover, although removal was performed by carrying out atmospheric-air release and washing a reaction container in the former whenever it processed the cloudiness of an inspection hole 1000 substrates, according to the inspection hole which formed TiO2 of this invention, cloudiness could be removed by performing steam discharge for 2 minutes for every 1000 substrates processing, and it became possible to raise an equipment operating ratio sharply. In addition, the plasma treatment equipment of this invention can be widely used for general manufacture, such as not only manufacture of a liquid crystal display but a semiconductor device.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] (a) - (c) is the explanatory view of the mechanism of flattening which removes a projection.
[Drawing 2] The graph which shows the etch rate of poly-Si and a resist.
[Drawing 3] The cross-section block diagram showing the configuration of the plasma treatment equipment of this invention.
[Drawing 4] The side elevation of the spacer of this invention.
[Drawing 5] (a) The explanatory view of damage on the front face of a microwave installation aperture, the explanatory view of polish of (b) microwave installation aperture.
[Drawing 6] The graph which shows the output of the steam discharge and the emission spectrometry detector using the inspection hole of this invention.
[Drawing 7] The cross-section block diagram showing the configuration of the modification of the plasma treatment equipment of this invention.
[Drawing 8] The cross-section block diagram showing the configuration of the modification of the plasma treatment equipment of this invention.
[Drawing 9] The configuration sectional view of poly-SiTFT.
[Drawing 10] The enlarged drawing of the shape of surface type of poly-Si.
[Drawing 11] (a) - (d) is the explanatory view of the mechanism of projection generating of poly-Si.
[Description of Notations]
1 -- A glass substrate, 2 -- poly-Si, 3 -- A resist, 4a, 4b, 4c-4n -- A projection, 5 --, 6--, 7--, 8--, 9--, 10, --, 11 -- Process chamber, 12 [-- A microwave waveguide, 24 / -- An inspection hole, 26 / -- TiO2 film, 32a, 32b / -- An adjusting screw, 36 / -- Beam section spacer] -- A processing stage, 13, --, 14 -- A microwave installation aperture, 15 --, 16, 16a, 16b, 16c -- A spacer, 17, 17a, 17b

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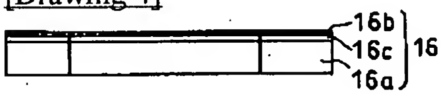
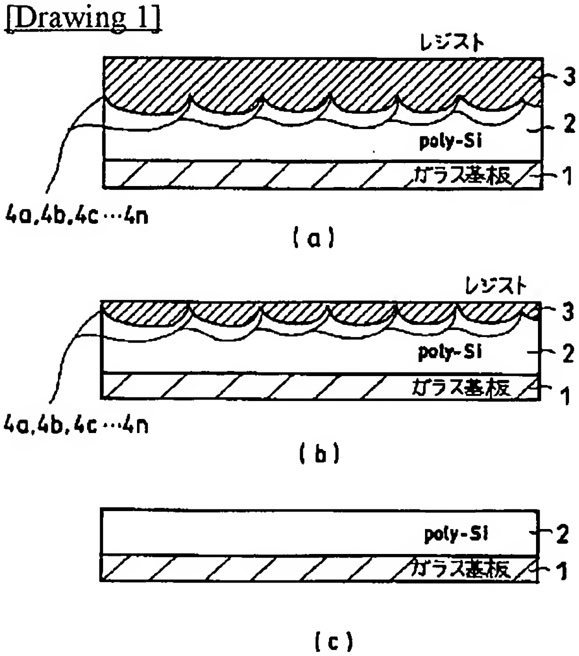
[Translation done.]

DRAWINGS

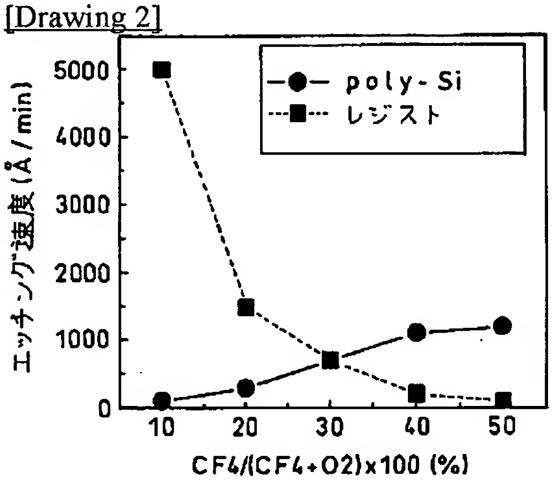
[Drawing 4]



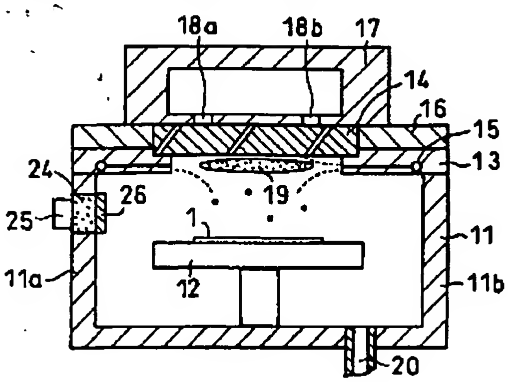
[Drawing 1]



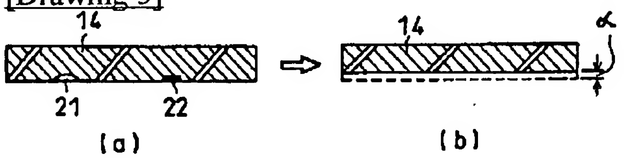
[Drawing 2]



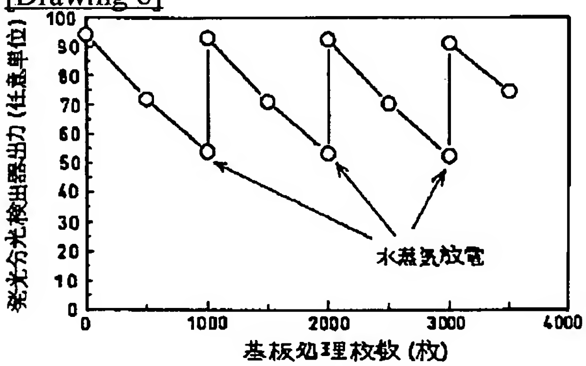
[Drawing 3]



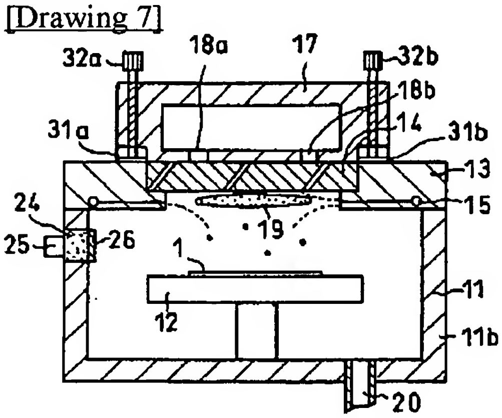
[Drawing 5]



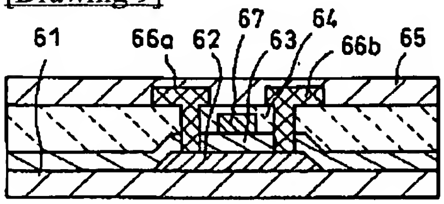
[Drawing 6]



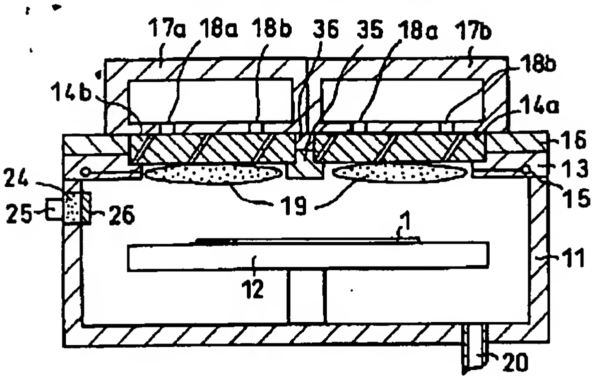
[Drawing 7]



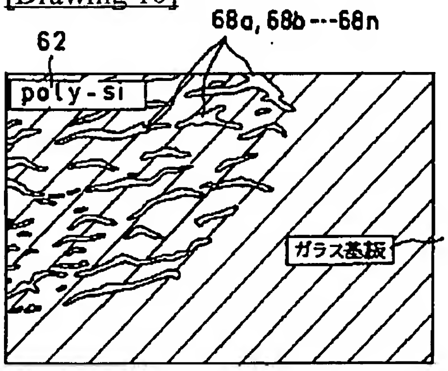
[Drawing 9]



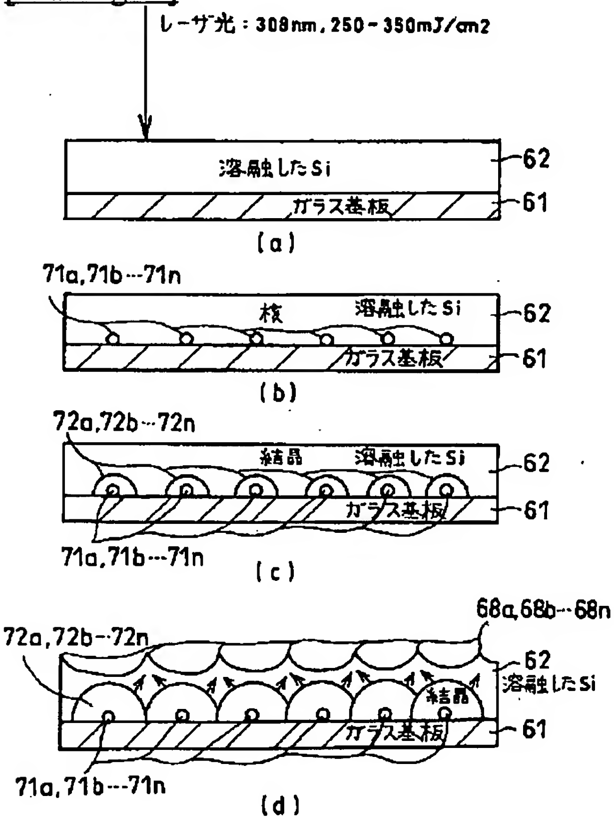
[Drawing 8]



[Drawing 10]



[Drawing 11]



[Translation done.]